

III. REPORT ON A COLLECTION OF
AQUATIC ANIMALS MADE IN TIBET
BY CAPTAIN F. H. STEWART, I.M.S.,
DURING THE YEAR 1907.

PART II.—OLIGOCHÆTE WORMS, MOLLUSCA AND
FISH (*Geographical*).

REPORT ON A COLLECTION OF THE SMALLER
OLIGOCHÆTA MADE BY CAPT. F. H. STEWART,
I.M.S., IN TIBET.

By J. STEPHENSON, *Major, I.M.S., Professor of Biology,
Government College, Lahore.*

(Plate viii.)

The collection of the smaller Oligochæta, made by Capt. F. H. Stewart, I.M.S., in Tibet during the year 1907, consisted of fourteen tubes, with the contents of which the following report deals.

The specimens were on the whole in a good state of preservation, but the free ends of the setæ of many specimens had suffered severely, and a number of the animals also had apparently been fixed with a brown staining substance, which hindered subsequent staining and seemed to interfere with the section-cutting process.

The contents of two of the tubes were unfortunately incapable of recognition :—

No. 68 (Mang-tsa, Tibet ; 14,500 ft. ; July 1907) contained a considerable number of specimens. These were the largest animals submitted to me ; they measured up to 35 mm. ; the segments numbered up to 175. They were all, however, sexually immature, and I was unable to distinguish either clitellum or genital organs ; possibly this was a young brood of some earthworm, *i.e.*, of one of the larger Oligochæta.

No. 80 (Mang-tsa, Tibet ; 14,500 ft. : 12-viii-07) contained three specimens, and sections show that they belong to the Tubificidæ ; but the setæ had, in this instance, suffered so severely that I was unable, in any of the specimens, to discover a single sound one in either dorsal or ventral bundles ; further discrimination is therefore impossible.

The contents of the remaining twelve tubes comprised only five distinct species, owing to the large number (seven) which contained the form described below as *Limnodrilus* sp. (?).

Chaetogaster orientalis was found three times ; one tube contained both this form and a *Nais*.

It will be seen that the collection is of considerable interest, in spite of the small number of species represented. One form (*Fridericia stewarti*) I have ventured to name as new ; it is possible that two others, the *Nais* and the *Limnodrilus* (?), are also new, though I do not feel justified in giving them distinctive names. Of the remaining two species, one, *Æolosoma hemprichi*, is already well known to be widely distributed (Europe, North America, Africa), and I have also found it at Lahore ; the other has so far been met with only by myself in Lahore ; but since the name which I gave to it had been previously appropriated, its present specific designation (*Chaetogaster orientalis*) makes its first appearance here.

The greater part of this investigation was carried out at the Central Research Institute, Kasauli, during the summer vacation of the present year (1908) ; and my best thanks are due to the Director, Lieut-Col. Semple, R.A.M.C., for kindly permitting me to pursue my work there.

Æolosoma hemprichi, Ehrbg.

No. 84. Gyantse, Tibet ; 13,120 ft. ; 27-viii-07.

Three specimens, of which the smallest appeared to be the broken-off posterior end of one of the others.

Length of both the larger specimens, including in each case one bud posteriorly, .7 mm. ; diameter, .09 mm. Colour, a rather dirty green ; the oil-drops in the skin quite disappeared. These latter are apparently incapable of preservation ; according to Capt. Stewart's notes their colour was an orange-brown, nearer an orange-red than a brown, and not unlike that of safranin stain. Segments, 8 or 9 distinguishable in the anterior or parent animal. Setae commencing a short distance behind the mouth, *i.e.*, in segment ii ; all are fine hair-setae, in both dorsal and ventral bundles ; length varying, longer and shorter in the same bundle, longest being about .1 mm. ; up to 5 in a bundle.

Prostomium large ; both specimens having curled themselves dorso-ventrally at the moment of fixation are seen in a lateral view in the preparations, and the breadth of the prostomium does not appear. According to a sketch of Capt. Stewart's from the living worm, it was rounded, not pointed in front, and broader than the following segments. The nerve-ganglion is shown as being deeply indented posteriorly ; this also could not be made out in the preserved specimens. The nephridia also are not recognizable.

In all the anatomical characters that can be ascertained this form agrees with *Æolosoma hemprichi*, except that its length is considerably less. The present specimens, probably somewhat contracted, and perhaps also diminished by the loss of some posterior buds, measure .7 mm. ; while *Æ. hemprichi*, according to Michælsen ("Oligochaeta," in *Tierreich*, Berlin, 1900), has a length of

2—5 mm. This can hardly, I think, be accounted a specific difference. I have recently [*Mem. Ind. Mus.*, i, No. 3b, p. 277, pl. xx (1908)] given a description of an *Æolosoma* from Lahore, identifying it as *Æ. hemprichi*, which is about the dimensions of these specimens from Tibet, and which is therefore also considerably smaller than *Æ. hemprichi* according to the figures given above.

Chætogaster orientalis, nom. nov.

1907. *Chætogaster pellucidus*, Stephenson, *Rec. Ind. Mus.*, vol. i, p. 237 (1907).
- No. 42. Se-chen, Tibet ; 13,100 ft. ; 22-iv-07.
Three specimens without sexual organs, and one fragment, together with the specimen of *Nais* sp.
- No. 49. Gyantse, Tibet ; 13,120 ft. ; 26-vi-07.
Two specimens without sexual organs ; dark brown in colour, probably due to mode of fixation.
- No. 83. Gyantse, Tibet ; 13,120 ft. ; 20-viii-07.
Two specimens without sexual organs, with several fragments consisting of detached buds.

The specimens probably consisted originally of complete chains of four or five individuals, which broke up at the moment of killing and fixing. They correspond closely with the species described by me as *C. pellucidus* from Lahore. Since writing that account (referred to above), however, I have, through the kindness of Dr. Walton, of Kenyon College, Gambier, Ohio, U.S.A., received a copy of his paper "The Naididæ of Cedar Point, Ohio," 1906 (*American Naturalist*, vol. xl, No. 478) ; he there describes as *C. pellucidus* a species found by him ; and since the name belongs by priority to that form, I have chosen *orientalis* for the species now under discussion.

I was at first inclined to see a difference between the present specimens and the form previously described by me in the relative length and thickness of the pharyngeal region as compared with the posterior part of the body. I find, however, that in the processes of fixation, etc., the pharyngeal region contracts both in length and breadth, while the body in the "crop" region appears to become broader than in life ; in specimens from Lahore so treated the result is a close approximation to the condition in which the Tibet specimens were found, *e.g.* :—

	Length of pharyngeal region.	Length of body posterior to pharynx.
Lahore form ..	.25 mm.	.71 mm.
Tibet No. 83 ..	.29 "	.75 "
Tibet No. 49 ..	.088 "	.24 "
Tibet No. 42 ..	.11 "	.35 "

Sketches made during life by Capt. Stewart confirm the above identification, showing the animal to possess about the same proportions as living specimens of the Lahore form.

It will be noted that the individuals of the collections Nos. 42 and 49 are considerably smaller than those of No. 83. Since, however, the size is the only point of difference I can discover, I have not separated them as a distinct form.

Since in distinguishing the species of the various families of the Naididæ so much depends on an exact description of the setæ, I will add here a somewhat more detailed account of those of this species than I gave in my earlier paper. The setæ are ventral only, slender, \int -shaped, unequally forked, the distal-prong being somewhat the longer, both prongs of the same diameter at the base, nodulus small, somewhat proximal to the middle of the length of the seta; setæ of segment ii a little stouter and distinctly longer (.14 mm., Lahore specimens) than the rest (average .11 mm., Lahore specimens).

Nais sp.

No. 42. Se-chen, Tibet; 13,100 ft.; 22-iv-07.

A single specimen, without sexual organs, along with specimens of *Chætogaster orientalis*.

Length 2 mm.; segments xviii *plus* a short posterior region without setæ, the seat of budding of new segments. Prostomium rounded. Ventral setæ with a \int -shaped curve, hooked and bifid distally, distal prong longer than proximal; nodulus not distinguishable in the present specimen; beginning in segment ii; 2—3 (perhaps more originally) in bundle. The anterior and posterior bundles differ somewhat; the anterior are composed of setæ about .074 mm. in length, with the distal prong of the forked end of the same thickness as the proximal; in the rest of the body the ventral setæ are about .055 mm. long, or three-quarters the length of those of the first few bundles, and the proximal prong is very considerably stouter than the distal. The thickness of the shaft of the seta is, however, the same throughout the body.

Unfortunately a small quantity of foreign matter adheres to the ventral surface of parts of the animal, and the setæ in these places being obscured, I am unable to say how many segments are comprised in the anterior group; probably, however, as in *N. obtusa*, the setæ of segments ii—v belong to the anterior, the rest to the posterior group.

The dorsal setæ begin in segment vi; each bundle appears to consist normally of one long smooth hair-seta, and one short, straight, singly-pointed needle-seta supporting it at its base, and scarcely projecting beyond the surface. These dorsal bundles, however, have been much damaged.

Two eyes are present as pigmented patches situated laterally at the level of the anterior lip of the mouth.

The pharynx occupies segments iii—v, the œsophagus vi, and a dilatation (stomach) of somewhat irregular shape appears in segments vii—viii. Posterior to this, the intestine is widely and regularly dilated in each segment. The anus is slightly dorsal.

The discrimination of the various species of the genus *Nais* depends largely on the characters of the setæ. Though the present specimen does not agree exactly with any form hitherto described (coming closest perhaps to *N. obtusa*, Gerv.), I prefer not to erect a new species on the basis of a single preserved specimen, especially as the dorsal setal bundles are largely incomplete. I myself examined previously some scores of living examples of a *Nais* common at Lahore before arriving at what I considered an adequate description of the dorsal setal bundles.

Fridericia stewarti, sp. nov.

No. 32. High Hill Gompa, Gyantse, Tibet; 14,500 ft; 28-iii-07.
Six specimens, mostly with sexual organs (ova and yolk).

Length 8 to 22 mm. Colour yellowish. Segments about 45 (43—46). Prostomium short, rounded; external annulation fairly well marked. Clitellum on segment xii and most of xiii; may spread partly over xi. Epithelium of surface markedly thicker over prostomium. Head pore apparently between prostomium and segment i; dorsal pores not distinguishable in my preparations.

The setæ (v. text-fig. 1) are in four bundles per segment, two ventral and two lateral; they are of the same character in all the bundles, being comparatively small with single blunt point, free extremity very slightly hooked, shaft straight or only curved in the slightest degree. They are arranged in fan-shaped form transversely in each bundle; those in the centre of each bundle are the smallest, and their size increases gradually towards the outermost components of the bundle, these latter being thus the longest. Each bundle is thus typically made up of a number of pairs of setæ, the members of a pair being of the same size, situated one on each side, and separated by the interposition between them of the smaller setæ of the bundle. In cases where the bundle consists of an odd number of setæ it can often be seen that



FIG. 1.—A seta of *Fridericia stewarti*; d. = its distal end.

one pair is incomplete, owing to the dropping out of a seta on one side. The arrangement is that peculiar to the genus. The number of setæ per bundle varies; posteriorly there are commonly 4 to 6 or 7 laterally, and 6 or 7 ventrally; anteriorly there are often more, most frequently perhaps 7 laterally, and 8 ventrally; 9 and

10 are also met with in the ventral bundles. The longest setæ are about .08 mm. in length.

The alimentary canal (fig. 1) begins as a narrow passage in segments i and ii; the pharynx occupies iii, having dorsally a marked thickening of its wall from which muscular bands radiate to be attached to the body-wall. The œsophageal glands, three or probably four pairs, are present in segments v, vi and vii; these are rounded or pear-shaped masses, not branched, attached to the alimentary tube, and also by strands to the body-wall; the most posterior are the largest. They are composed of large rounded cells which appear to be comparatively loosely connected together; the loose connection of the cells is also seen in sections.

Surrounding the alimentary tube in segment viii is a spherical structure (fig. 1, *ch.*) through which the tube is continued uninterruptedly; this structure is itself hollow, its cavity being divided up by a number of septa; its walls are fairly thick and apparently somewhat similar in character to those of the alimentary tube; the structure is clothed externally by low peritoneal cells. In a series of (more or less) horizontal sections there appear two lateral dorsalward extensions of this chambered structure, which embrace between them in the middle line what is apparently the thin-walled dorsal vessel containing coagulated blood; the dorsal vessel appears to communicate with the sinuses of the chambered structure.

There appear (in sections) to be fairly definite blood-sinuses surrounding the alimentary tube, between the tube and the peritoneal cell layer, in segments ix and x; the sinus in x contains coagulated blood. Further back, behind the genital region, in segments xiii and posteriorly, there is also a fairly well-marked peri-intestinal space, though less definite perhaps than anteriorly in segments ix and x, and possibly of artificial origin.

There is no demarcation between œsophagus and intestine. The peritoneal cells around the tube are very tall in segments ix and x, and again behind the genital region to the posterior end of the body.

The lymph-corpuses (fig. 2) are mostly oval, with rather sharp ends; some are round or somewhat irregular in shape. Both kinds are granular; a faint round vesicular nucleus with a nucleolar spot can be distinguished in them. The blood was apparently colourless; the distribution of the blood-vessels is unfortunately not recognizable.

The nephridia consist of anteseptal and postseptal portions, the anteseptal being, according to the appearances shown by horizontal sections, about half as thick and two-thirds as long as the postseptal; it projects forwards into the anterior segment, while the postseptal, appearing as a thick granular mass of oval shape, passes outwards and backwards to open externally in front of the level of the setæ.

The cerebral ganglion is situated in segment i; its shape is difficult to make out; it is apparently more deeply indented in

front than behind. The ventral nerve-cord is formed in the second segment by the union of the commissures.

I am unfortunately unable to give a description of the male organs from the specimens at my disposal ; and with regard to the female organs also the account must for the present be incomplete. Clusters of developing spermatozoa (few only) were seen in segment x ; clusters of ova in xi and posteriorly, some even at the extreme posterior end of the animal ; there are thus apparently (as is usual in the family) no egg-sacs formed. Somewhat opaque masses of yolk-matter, in small granules, occupy the clitellar region and part of segment xi. A genital gland, presumably testis, appears attached to the posterior face of septum 10-11.

The spermathecae (fig. 1, *sp.*) are situated in segment v, opening anteriorly ventro-laterally between iv and v. They are tubular, with narrow lumen, of a much elongated pear-shape, the broader part being anterior. They have thick walls ; the passage of communication with the exterior is short and narrow ; they are attached behind to the dorsal wall of the alimentary canal, but I have not been able satisfactorily to demonstrate a continuity of the lumen of the spermatheca with that of the œsophagus ; such may, however, possibly exist.

The clitellum is seen in sections to consist of two kinds of cells intermingled ; of these some are quite clear, and others granular in appearance. The same distinction is also evident in a superficial view of the whole surface of the clitellum, the clear and granular cells appearing as clear and granular areas.

Systematic position.—The arrangement of the setæ described above is peculiar to the genus *Fridericia*. Of the species of this genus, the larger number present diverticula in connection with the spermathecae ; and of those (*F. alpina*, *alba*, *bulbosa* and *striata*, according to Michaelsen, "Oligochæta" in *Das Tierreich*, 1900) which have no such diverticula, *F. striata* is the only one which presents anything like so large a number of individual setæ in each bundle. In this form, however, the salivary glands are branched at the extremity, the ampullæ of the spermathecae are bulbous in shape, and in connection with the passage to the exterior are two somewhat spherical glands ; these characters are absent in the present species.

Though the above account of the present form is incomplete, it would nevertheless appear to be distinguishable by several well-marked characters from the other members of the genus ; and since I think the description will allow of its being recognized when next met with, I have ventured to distinguish it by the specific name *stewarti*. I have placed a type specimen, in balsam, in the Indian Museum, Calcutta, and also a series of longitudinal sections ; the specimen mounted whole shows the characters of the spermathecae distinctly, and has ten setæ in one of the ventral bundles of the sixth segment.

Limnodrilus sp. (?).

- No. 13. Te-ring Gompa, Tibet ; 14,000 ft. ; 22-i-07.
A single imperfect specimen, immature sexually.
- No. 15. Te-ring Gompa, Tibet ; 14,000 ft. ; 22-i-07.
Eleven specimens, mature and immature.
- No. 18. Te-ring Gompa, Tibet ; 14,000 ft. ; 22-ii-07.
Two specimens with some fragments ; some showing sexual organs.
- No. 33. High Hill Gompa, Gyantse, Tibet ; 14,500 ft. ; 28-iii-07.
Two specimens, with two fragments of anterior end ; sexually mature.
- No. 40. Te-ring Gompa, Tibet ; 14,000 ft. ; 14-iv-07.
Ten specimens, some with sexual organs.
- No. 54. High Hill Gompa, Gyantse, Tibet ; 14,500 ft. ; 8-vii-07.
Eight specimens, some with sexual organs.
- No. 57. High Hill Gompa, Gyantse, Tibet ; 14,500 ft. ; 10-vii-07.
Six specimens, some with sexual organs.

I cannot separate the above, taken at various times at two places in the neighbourhood of Gyantse. The specimens were on the whole well preserved ; several batches were stained a deep brown, probably from the fixing agent employed, and these did not stain well nor give good sections ; the setæ of all the batches were very much broken.

Length frequently about 8 mm., specimens up to 20 mm. were met with. Diameter to 4 mm. Segments 40—64. Clitellum on segments xi and xii primarily, spreading to x and xiii and even encroaching a little on ix. Prostomium well marked, bluntly conical, marked off by a distinct groove ; external annulation distinct, double in the anterior segments according to sketches by Capt. Stewart from life ; this double character is recognizable, though apparently somewhat less distinct, in the preserved specimens also.

Setæ dorsal and ventral of same character throughout (*v.* text-fig. 2), both series beginning in segment ii ; they have the usual \int -shaped curve, are bifid distally, both prongs being of about the same length, the distal prong slenderer than the proximal ; nodule indistinct, as a slight swelling at the junction of middle and distal thirds, just within the body-wall ; length of setæ about .08 mm., but variable ; number in bundle usually 4--6, occasionally 7.

FIG. 2.—Seta of *Limnodrilus* sp. (?)

The alimentary tube is narrow in segments i, ii ; pharynx in iii ; œsophagus extends to ix, and the tube expands in x to form the intestine, if genital products are not present to compress it.

There is nothing that can be called a stomach ; the intestine is constricted at the septa, and bulges between the septa ; its epithelium is columnar ; the tube is covered externally by roundish, slightly staining granular peritoneal cells, which may be so numerous in places as to obliterate the body-cavity.

Besides these peritoneal cells, there are body-cavity corpuscles of circular shape, nucleated, very coarsely granular, the granules appearing as highly refractive particles similar to those in some species of *Nais*.

The circulatory system is not sufficiently distinct for description ; the same may be said of the nephridia. The cerebral ganglion is in segment i, not in the prostomium, and the nerve-cord has the usual relations.

The testes (fig. 4, *tc.*) are in segment x, along with the spermathecæ ; the funnel (fig. 4, *f.*), also in x, is large, regular in shape, sessile on the septum ; the vas deferens (fig. 4, *v.d.*), whose walls are composed of a layer of somewhat cubical cells, passes backwards in xi, presenting itself as a fairly stout tube, with perhaps a gentle curve or two, but not coiled in any way ; a single longitudinal section will sometimes cut nearly the whole length of the tube ; probably in the extended condition of the animal it was almost straight. It opens into the atrium at the inner end of the latter. The atrium (figs. 3, 4, *atr.*), in segment xi, is a somewhat pear-shaped chamber, its broader end being internal ; it is prolonged into the penis (figs. 3, 4, *pen.*), a short and somewhat inconspicuous structure, whose chitinous sheath also is hardly to be made out in my preparations. The prostate (figs. 3, 4, *prst.*) is a well-marked mass of cells surrounding the inner end of the atrium on all sides.

The spermathecæ (fig. 3, *sp.*) are in segment x, not extending beyond this segment ; they may be bilobed or not, or that of one side may be bilobed, the other spherical. The lining epithelium is much elongated near the external aperture, and some of these elongated cells show clear spaces in their substance ; the same condition of the epithelium is seen over the projection of the wall into the cavity of the spermatheca where this organ is bilobed. A hyaline non-staining material fills the spermathecæ, aggregated frequently into oval or elongated masses (? spermatophores).

The ovaries (fig. 3, *ovy.*) are in segment xi, in close connection with the vas deferens of each side. I have not identified the oviducts.

The genital sacs (sperm-sac and ovisac) are large ; the male products may extend forwards as a well-marked rounded mass into segment ix. The combined sacs extend backwards through a large number of segments, often to xviii, and even to xxv. The male products are the more conspicuous and usually more bulky ; the female products, ova with granular yolk, are usually posterior, though they may have sperm-morulæ behind as well as in front of them.

In a few specimens the ventral setæ of segment xi are

modified (genital setæ), the prongs of the distal end being much shorter, and the nodulus more distinct (v. text-fig. 3).



FIG. 3.—Genital setæ of *Limnodrilus* sp. (?); by the side of the fully-formed seta is a young one in process of formation: compare with text-fig. 2.

Of the three genera of Tubificidæ which possess only forked setæ in the dorsal as well as in the ventral bundles,—*Limnodrilus*, *Clitellio* and *Vermiculus*,—the two latter are immediately excluded by the characters of their genital apparatus, since *Vermiculus* possesses single male and spermathecal pores, and *Clitellio* has no prostate. It seems probable that the present form is a *Limnodrilus* and that the differences from the usual descriptions of that genus are, in part at least, due to the fact that the examination has been made on preserved material. A few points may, however, be further mentioned.

One would not expect the integumental blood-vessels, which form one of the characteristics of *Limnodrilus*, to be recognizable in preserved specimens; but I am a little surprised that the “ hearts ” of segment viii, or viii and ix, give so little evidence of their existence; they are immediately visible, for example, in preparations of a small *Limnodrilus* from Lahore (species undetermined, as I have not yet met with mature specimens), in which also the main vessels can be followed with ease; this is by no means the case with the Tibet specimens. It is to be remembered, however, that the “ hearts ” need not be specially enlarged vessels; their contractility is their special characteristic.

The vas deferens, again, is in *Limnodrilus* distinguished by its great length, and by being narrow and much coiled (Beddard, *Oligochæta*, p. 249). This cannot be said of the present form, in which it is comparatively short and stout, and is not coiled; and this difference does not seem to be due to the fact of the animals being examined in the preserved state.

I have not been able to observe the character of the spermato-phores mentioned by Beddard, namely that the free ends of the spermatozoa form a spiral on the outer surface.

Admitting, however, this form to a place in the genus *Limnodrilus*, the species must, I fear, remain undetermined; the discrimination of the various species depends largely on the characters of the penis and its sheath, and to some extent also on the shape of the brain,—organs of which unfortunately I can only give incomplete descriptions. I may refer to Beddard's words (p. 251, *op. cit.*), referring to the occurrence of the genus in Hawaii: “ I cannot distinguish any marked peculiarities which justify me in giving it a new name, though on the other hand I have not yet identified it with any of the known forms. Living material is essential for the proper description of these Tubificids.”